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THE
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by

GWEN CROSS

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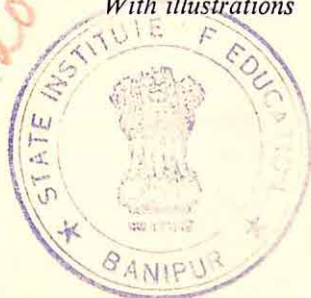
BOOK 8

IRRIGATING THE SOIL

BY

GWEN CROSS

With illustrations



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CHAPTER 1

IRRIGATION—A VERY OLD CUSTOM

By irrigation we mean the supplying of water to land which is very dry in order that plants will grow on it. Plants will not grow without water, but in many countries there is not enough rain, or there is not enough rain at the right time. People there cannot grow the food they need, so they have to take water to the land in order to grow crops. They irrigate the land.

Hundreds of years ago the people of Egypt, Babylon, Greece, and Rome learned how to do this. We know this from writings and pictures they left on stones, the walls of caves, clay tablets, and papyrus rolls or books (see *Things We Use*, Book 15, *Paper and Books*).

The water used to irrigate the land must be taken from a well, a river or a lake, either by letting it flood over the land or by taking it in furrows, ditches, canals, or pipes. These ways of irrigating the land have been used for hundreds of years, and they are still in use today.

In some countries rivers overflow their banks at a certain time each year. This happens because there is much rain in the mountains where the rivers begin, or because the snow and ice on the mountains melts when warmer weather comes. Some of the big rivers which overflow their banks each year are the Nile in Egypt, the Yangtze-Kiang in China, and the Mississippi in North America.

Egypt is a very dry country because it gets very little rain. Long ago the Egyptians saw that without the yearly floods their crops would not grow. Each year they waited until the Nile had overflowed its banks. Then, when the

flood water had flowed away or sunk into the soil, they planted their crops.

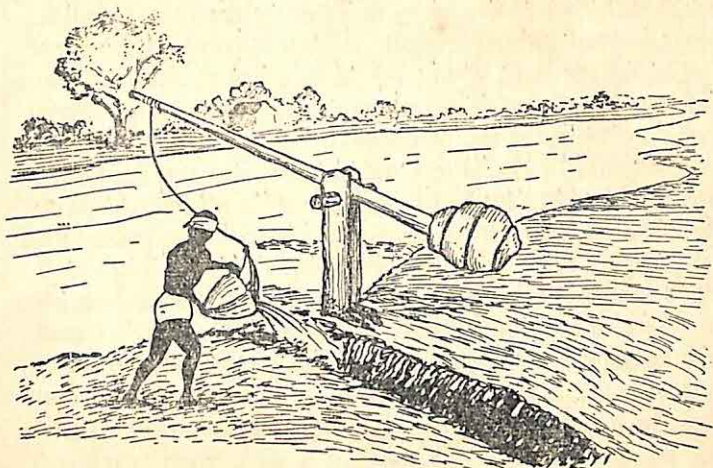
They made basins and built low walls of soil and stones round their fields, and some of the water collected in these when the river overflowed. From these basins and fields, some of the water was allowed to run into fields farther away from the river. After a month or two the floods went down, and the water that had not sunk into the ground returned to the river.

These Egyptians found another way of taking the water to fields still farther from the river. They made canals, which filled up when the river was in flood, and took water to the places which the flood did not reach. Then they had to find some way of getting the water up from the canal on to the land above it, and of giving each field the amount of water it needed.

Again they built low walls round each field, so that they could let the water into the field or keep it out, as they wished. They dug ditches from the banks of the canals to the fields, and they had a number of ways of getting the water up from the canals to the ditches. One of these ways was by using the *shaduf*. This was made by tying a leather bag, like a bucket, to a rope, the other end of which was tied to the thin end of a long pole. This pole was fixed to two upright poles so that it moved up and down like a see-saw.¹ The farmer pulled on the rope, the bag went down into the water and filled up. Then the weight of the thick end of the pole raised the bag to the top of the bank of the canal, and the farmer emptied the water into the ditch. Sometimes two men worked a *shaduf* with a bigger bag.

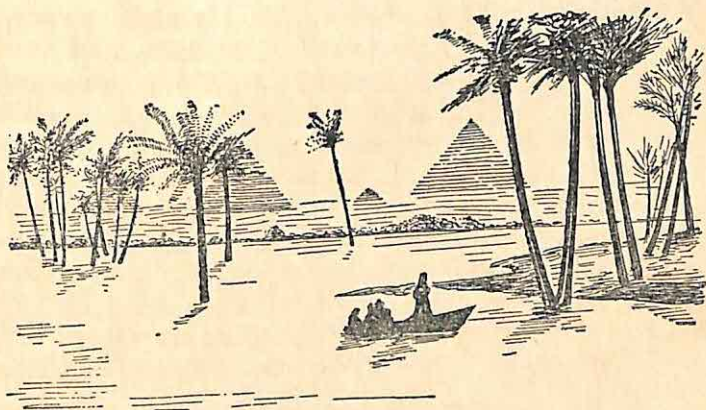
When a field needed water, the farmer made an opening in the low wall round it and let the water run in. When

¹ See-saw: a board laid over a log: a child sits on each end, and they move up and down.



Picture 1. A Shaduf

that field had had enough, he closed the opening, and made one in the wall of another field. It was slow work raising water from the canals with the shaduf and the other things the Egyptians used, but it was not difficult work



Picture 2. The Nile in Flood

and it enabled them to grow more crops for their families. The important thing was that they could *control* the water.

Without the Nile, Egypt would be a desert country, and without irrigation few people would be able to live there. From the times of the Pharaohs many people have lived in Egypt, and for all these centuries they have depended on the Nile floods and irrigation for their food. Although it is in the middle of a desert, Egypt long ago became a rich country with many people. In Babylon and Mesopotamia (Iraq) the people also learned to irrigate the fields with water from the River Euphrates and the River Tigris, and these countries too became rich and great.

THINGS TO DO

1. Look at your atlas and find the rivers you have read about in this chapter.
2. Read about books and paper in *Things We Use*, Book 15.
3. If any part of your country has irrigation, try to find out how it is done. If you can get pictures, cut them out and paste them in your book.
4. Try to get pictures of a shaduf and of any of the other things which people used long ago, and perhaps still use, to irrigate their fields.

QUESTIONS

1. What is meant by irrigation?
2. In what kind of country do fields need irrigation?
3. Name two ways of getting water to the fields.
4. How did the Egyptians learn to control the water that went to their fields?
5. What did they do to get the water to fields far from the Nile?
6. How did they control the water flowing into a field?

CHAPTER 2

OLD WAYS OF IRRIGATION IN USE TO-DAY

MANY centuries ago the people of India, Ceylon and China learned how to irrigate their land. In these countries rice is the chief food, and the kind of rice they often plant is called swamp rice, because the young seedlings are planted in fields under water (see *Things We Use*, Book 4). The Indians and Chinese make low walls of soil round the fields to keep the water on the land.

If we travelled overland from Port Said to Indo-China, we would see men getting water to their fields in many different ways. In Tongking, Indo-China, the women make a long, narrow kind of basin with the bark of a tree. They fill this with water from a lake or river, and empty it into the ditch that takes the water to the fields.

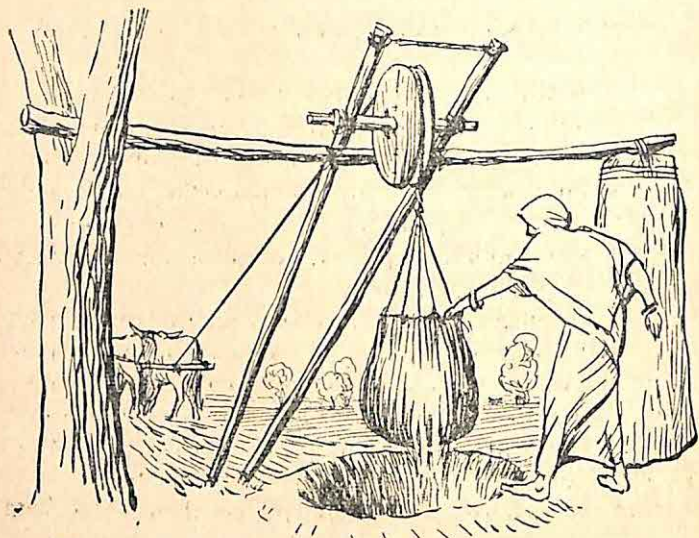
In many Eastern countries people get their water from deep wells. If we visited some of the villages of these lands, we would see the people getting the water up from the wells in the same way as their forefathers¹ did before Christ was born. They have no pumps or machines, so this work has to be done by men or animals.

A long board is put over a tree trunk or log, so that one end of the board is above the well. To this end are tied bags made of goat or bullock² skins. The ends of the board move up and down like a see-saw, and men walk back and forward on the board. When they walk towards the well, that end of the board goes down, and the bags

¹ Forefather : a person from whom one is descended.

² Bullock : a young bull.

dip into the water. When they walk away from the well, the other end goes down and the bags come up full of water. A man standing beside the well empties the water into a ditch, which takes it to the fields.

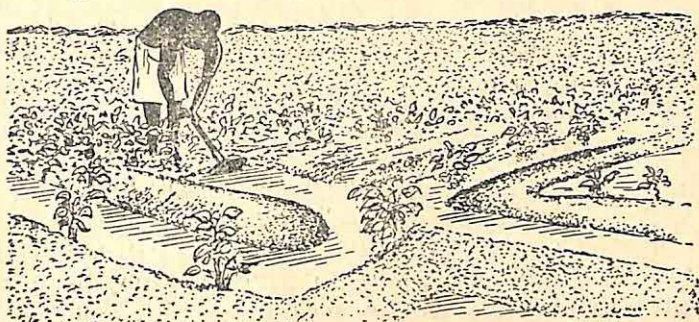


Picture 3. Bullocks pulling up a bag of water from a well

Sometimes the rope to which the bags are tied goes over a small wheel above the well, and is attached at the other end to a pair of bullocks. The bullocks walk up and down a slope, which leads to the well. When the bullocks walk away from the well the bags come up full of water.

In Persia bullocks are made to walk round in a circle so that they turn a big wheel above the well. Over this wheel is an endless rope, which hangs down into the water in the well. To the rope pots are tied a foot or so apart. As the wheel turns, the pots go down empty into the water and come up full. Then, as each pot passes over the top

of the wheel, it empties itself into a wooden box with one end missing. This box guides the water into the ditch leading to the fields.



Picture 4. Irrigating a cotton field in the Sudan

If the water from the well is being used to irrigate a rice field, the farmer lets it flood all over the field. If there is another kind of crop, such as maize or cotton, in the field, the water is made to flow from the ditches into furrows between the rows of plants. The ditch leading from the well goes along one side of the field, and the rows of plants and the furrows between the rows are at right angles to the ditch. As the water flows in the ditch, the farmer opens the end of the first furrow with his hoe. When he thinks that enough water has gone into this furrow for the plants on either side of it, he closes it, and opens the end of the next one. He goes on in this way until every furrow has had as much water as the plants need, and the whole field has been irrigated.

If the crop is one like bananas, the farmer makes a furrow round each group of plants, and about 2 to 3 feet away from it. As the water flows in the central furrow, he allows it to go into the group furrows one after the other. If the soil is very dry, he makes a wide furrow round each group of plants. He digs out this furrow making a

ridge (low hill) near the stems and another ridge 2 or 3 feet away from them. This makes a kind of basin round each group of plants. The water, which flows from the main furrow, will not wet the stems of the plants because of the ridge round them. As before, he lets the water into each basin in turn, until he has irrigated the whole field.

If we could walk round the fields of some villages in India, we would see people irrigating them in all of these three ways. We would see men drawing up water from the well. Women would be planting rice seedlings in a field flooded with water from the well. Boys and girls with hoes would be guiding water into the long furrows between rows of maize or sugar-cane. We would see others letting water into the furrows round groups of bananas. Everyone would be helping—doing, without hurry, the work of irrigating the fields as their fathers, grandfathers, and great-grandfathers have done for centuries.

When men have no machines to help them, and have only their hands to work with, they do their work in the same way century after century. Their customs do not



Picture 5. Women planting rice seedlings

change very much or very quickly. They change so slowly that we talk about the "unchanging East", because in these countries the people, and especially the farmers, still work in the same way as their forefathers did long ago. But changes are now coming to these lands, and their peoples want to know how the western nations do their work. Perhaps it will not be very long before some of the old ways go, and machines come in to help with the work of drawing water from the wells and making it flow to the fields.

THINGS TO DO

1. Try to find pictures showing people working on the land in Eastern countries. Look for pictures of wells, ways of irrigating the fields, water-wheels, bullocks at work, men using hoes, etc. If you may, cut them out and put them in your book. Write a sentence under each.
2. If you can, try to irrigate part of your garden in some of the ways you have read about in this chapter.
3. Find out what a see-saw looks like. You can make a small one by laying your ruler across a reel of cotton.

QUESTIONS

1. Describe how men get water from a deep well in India.
2. How does a Persian water-wheel work?
3. How would you irrigate a field of banana plants?
4. How would you make a "basin" round a group of plants?
How does the basin help?
5. How is a field of maize irrigated?
6. Why do we speak of the "unchanging East"? Is this still true to-day?

CHAPTER 3

NEW WAYS OF IRRIGATION (1)

Dams, weirs, reservoirs

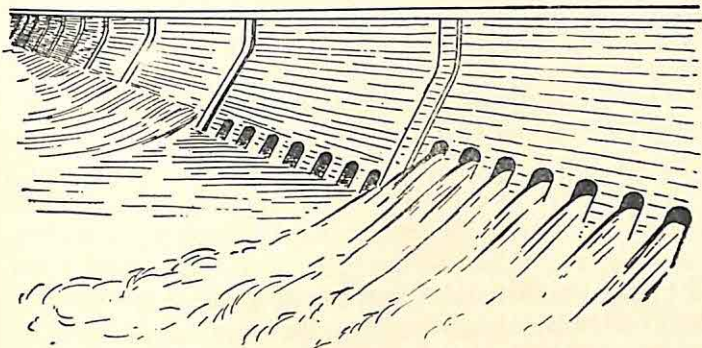
PEOPLE have learned that plants not only need water to grow, but that, if they are given more water than they seem to need, they often grow more quickly, are stronger, and give better and bigger harvests. Grass grows much better if it is given plenty of water. If the grass is very good, the cattle that eat the grass give much good milk and meat. Sometimes a farmer can multiply his harvest three or four times if he can give the plants as much water as they will take. Irrigation will not only change desert land into good garden land, but it will also change a good harvest into a very good one.

In this century large stretches of waste land are being turned into good farming land. To do this great walls are being built to hold back and store water. In the United States alone there are one million square miles of poor land that will be changed to good farm land when enough water can be taken to it.

In Australia hundreds of square miles of land, that was once covered with small, poor bushes, has now very good grass growing on it. Many cattle and sheep graze on this grass. There are big farms from which come many tons of wheat and fruit each year. This has happened because the land is now irrigated, and millions of acres of land have been changed in this way.

Large stretches of poor land need many thousands of gallons of water to make it good. Big lakes must be made

for collecting the water and storing it until it is required on the land. Canals and ditches have to be dug to take the water from the lakes to the fields. But first great walls must be built so that the water can collect to form the lakes. These walls are called *dams*.

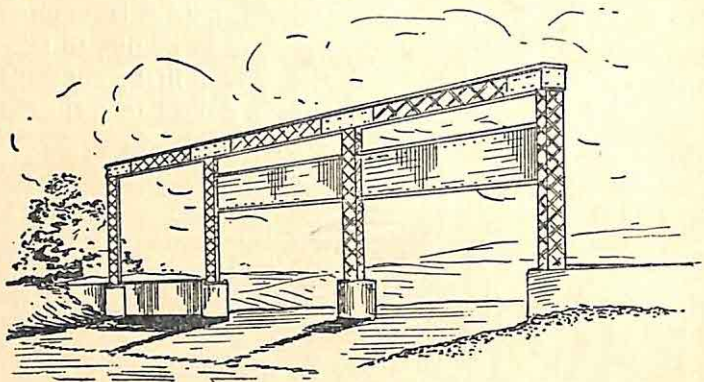


Picture 6. Aswan Dam

Dams are built across rivers or valleys to hold up the water and keep it from flowing away. A dam which is meant to hold up much water has to be very strong, for water is heavy and its weight gives it great power. Dams across valleys are built of great stones and concrete¹ strengthened with iron. Water that drains into a valley behind a dam cannot flow away. It collects there and spreads out into a lake. At each end of the wall there is often a place where the water can overflow safely if the lake becomes very full. A lake like this, which has been made for storing water, is called a *reservoir*.

A *weir* is a wall built across a river to raise the level of the water behind the weir. When the water reaches the required level it flows over the top of the weir and down

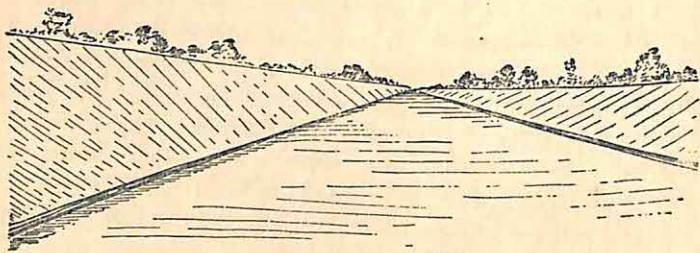
¹ Concrete: a mixture of cement, sand and water that hardens as it dries.



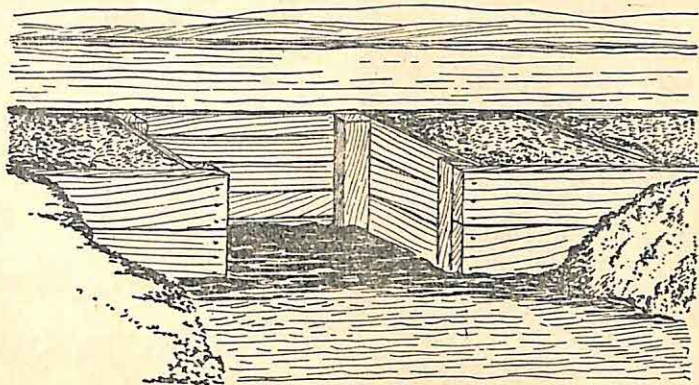
Picture 7. A weir

the river bed. Some weirs are built with gates which can be lowered to raise the level of the water behind them, or raised when a store of water is not needed.

The water for irrigation is taken from reservoirs, lakes and rivers by canals. The flow of water into the canals is controlled by gates or pumps. From these big canals, the water flows into smaller ones, and from them to large ditches, then to small ones. So the water reaches the fields where the farmer wants it.



Picture 8. A main canal

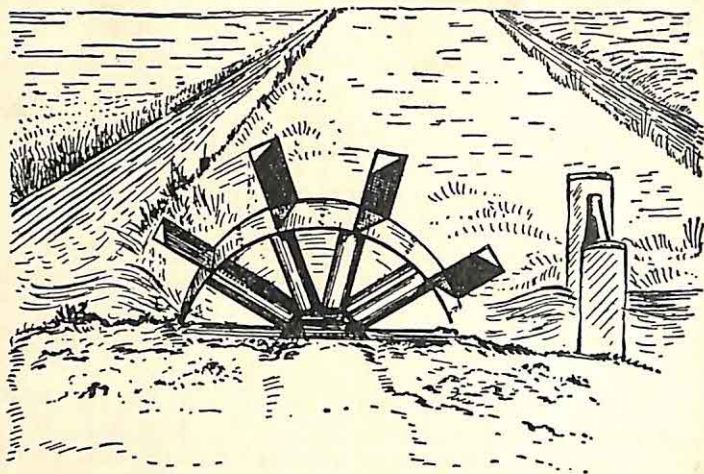


Picture 9. Wooden gate controlling flow of water from canal to ditch

The flow of water in the ditches is often controlled by doors made of wood or concrete. These doors are raised or lowered by the farmer to give him the amount of water he requires, and they can be closed completely so that no water comes through.

The great dams, the weirs, the reservoirs and the canals cost a great deal of money to make. It is usually the Government who give this money, because they want the people of the country to have enough food. The water helps the farmer to grow bigger and better crops, and he gets more money from selling his produce. So it is only fair that he should give some of this extra money to the Government to help to pay for the work that has been done to store the water and take it to him. Usually he is made to pay for the amount of water he uses, so that a farmer who uses much water pays more than one who uses only a little.

The amount of water flowing into a ditch can be measured by a machine called a water-meter. One of these meters is put in the ditch where the water enters the



Picture 10. A water-meter

farmer's land, and it tells how many gallons flow into it. The Government send a man from time to time to read the meter, and the farmer then gets a bill telling him how much he has to pay.

THINGS TO DO

1. Find out if there are any reservoirs, dams, or weirs in the district or country where you live. Where are they? What are they called? Find out all you can about them.
2. Do you know of any districts near you where the land is poor but could become good if it had plenty of water? Are there any districts with poor land that has had water taken to it? If you can, go and visit them.
3. See if the Government of your country gives away small books about irrigation. If you can get any, read them and talk to people about the good that comes from irrigation.

4. If you are near any irrigation works, go and look at the canals, the ditches, the control doors, and the water-meters.

QUESTIONS

1. What is a dam? a weir? How do they help in the work of irrigation?
2. How does having plenty of water help the farmer?
3. How is the water taken from a reservoir to the farmer's land?
4. Why is it right that the farmer should pay for the water he uses?
5. How is the water measured as it flows into the farmer's ditches?
6. How is the water controlled as it goes from the reservoir to the large canal, and from the Government ditch to the farmer's ditch?

CHAPTER 4

SOME FAMOUS DAMS

IN many countries there are now great dams and reservoirs, which store millions of gallons of water for irrigation and other works. At Aswan on the River Nile there is a dam with a wall 174 feet high and nearly 7000 feet long. From the reservoir behind it, canals take water many miles to cotton fields, which, without the water, would be desert land.

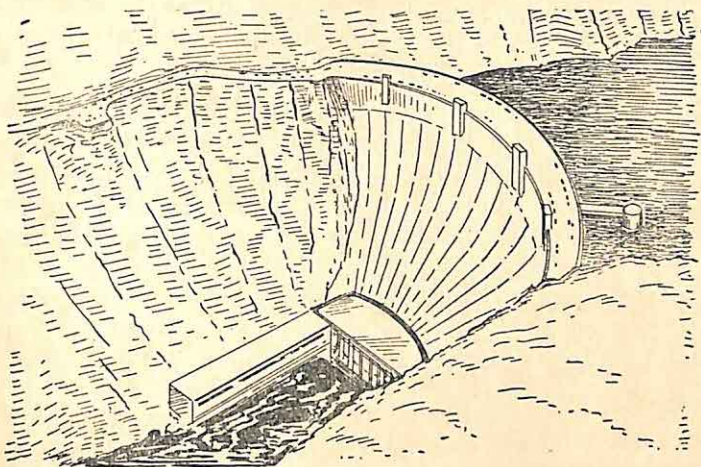
The Punjab in Pakistan is a very dry country, though several rivers flow through it. One of these rivers is the Indus, and in 1931 the Government, which was then under

the British Government, finished building a dam at Sukkur on the Indus. The Sukkur Dam is nearly a mile long, and from the reservoir seven canals take the water to the fields. The canals irrigate between 5,000,000 and 6,000,000 acres of land, on which wheat, rice, and other food crops are grown.

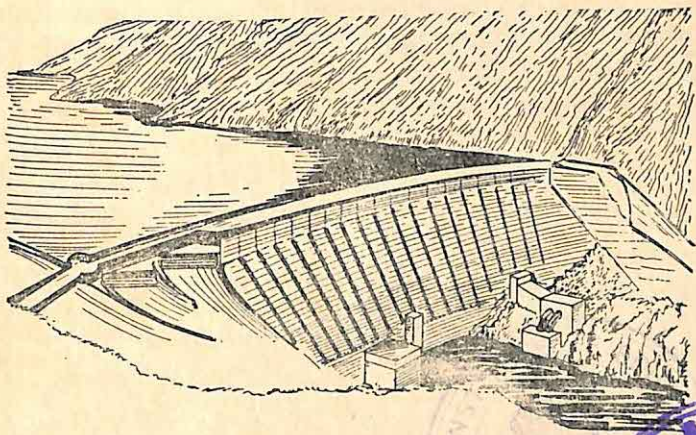
There are many other dams in Pakistan and India, and they are of great help to the people of both countries. There rain falls only in some months of the year, the other months being dry. If the rains are late, or if there is not enough rain, the swamp rice seedlings cannot be transplanted at the right time, because the fields are not flooded. Perhaps the seedlings die before they can be transplanted, or perhaps they are transplanted late and do not grow well. Then the harvests are small, and the people do not get enough to eat. If there is not enough food, people who need it must pay a great deal of money to get it, and many people have neither food nor money. They become sick and weak, and many die. By building dams and irrigating the land the Government has made sure that the crops can be grown, and has saved many people from sickness and death.

In the United States also there are many great dams. On the Colorado River the Boulder Dam is 726 feet high and 660 feet wide at the bottom. The Roosevelt Dam in the Salt River Valley in Arizona is 280 feet high and over 1100 feet long. These are only two of the many dams in the United States and in Canada.

Australia and New Zealand have great dams. The Burrinjuck Dam in New South Wales has behind it a reservoir which has more water in it than Sydney Harbour. The Hume Dam, on the border of New South Wales and Victoria, controls the flow of the Murray River for the benefit of these states and South Australia as well. Australia's largest dam is the Eildon Dam on the Goul-



Picture 11. Boulder Dam



Picture 12. Burrinjuck Dam

burn River in Victoria. It is 3000 feet long and over 1000 feet wide at the bottom and helps in the irrigation of many square miles of land.

In South America, in Africa, and in Asia, dams are being built and reservoirs made in order to get more water for the soil when it is needed. Many square miles of land that would be dry and useless is being changed into good farming land; farmers are getting bigger and better harvests and people are getting more food. In every country, every one should help and encourage Governments to push on the work of irrigation. By doing this we help ourselves, our own country, and the world as a whole.

THINGS TO DO

1. Try to find out all you can about dams in New Zealand, Japan, Africa and South America. What is the latest or the biggest dam in each of these countries?
2. Try to find pictures of big dams. If you may, cut them out and paste them in your book. Look in your atlas for the rivers mentioned in this chapter.

QUESTIONS

1. How does irrigation save many people in India from sickness and death?
2. In which country is the Aswan Dam? For what crop is the water mainly used?
3. Where is the Punjab? Find out the names of the rivers that run through it. Where do they come from and where do they go?
4. Name two of the biggest dams in the world. Name the countries they are in, and the river or valley each is built across.

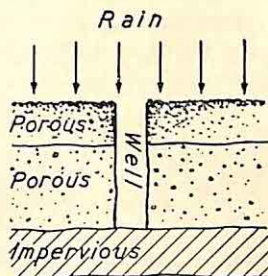
CHAPTER 5

NEW WAYS OF IRRIGATION (2)

Artesian wells, bores, pipes, sprays

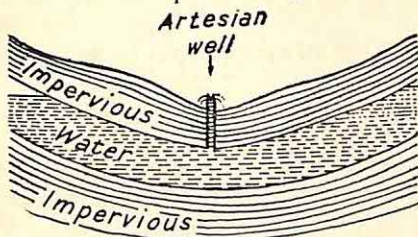
Artesian wells and bores

In Chapter 4 in Book Seven you read about porous and impervious layers of soil and rock. Water sinks through the porous layer and collects at the lowest part of the top of the impervious layer. Ordinary wells are dug through a porous layer to the top of an impervious layer, and water collects in the well.



Picture 13. Ordinary well

There is another kind of well that is dug through an impervious layer to a porous layer under it. Water is held in this porous layer by another impervious layer below, and the well reaches this water.



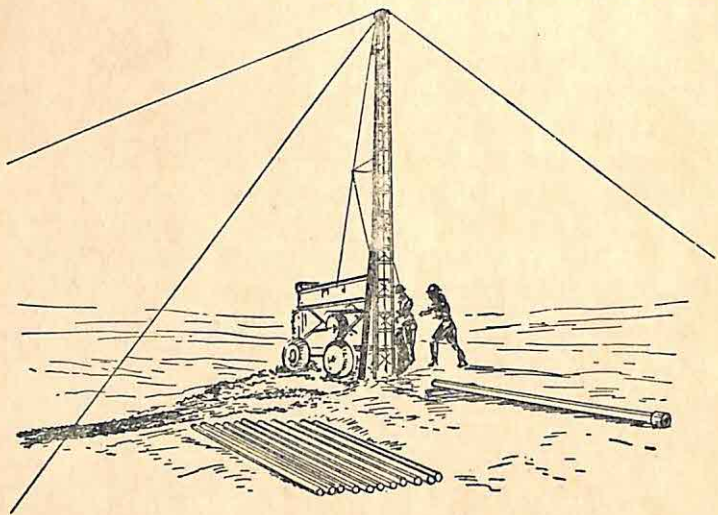
Picture 14. Artesian well

Wells like this were made about 700 years ago at Artois, in France, and the name "artesian" comes from Artois.

When men had only sticks or spades to dig with, they could not make their wells very deep. There are now machines which can make much deeper wells. These machines dig the hole and bring up the soil and broken rock to the surface.

There is also a machine which, instead of digging a wide hole, pushes a narrow pipe into the soil. This pipe is made in short pieces, and the end of one piece screws on to the end of the one before it. As each piece is pushed into the ground, the machine screws another piece on to it. In this way the pipe can be pushed far down into the ground. A pipe of this kind is called a bore.

This pipe becomes an artesian bore if it goes through an impervious layer to a porous layer, which has another impervious layer below it. Sometimes there is much water in the porous layer. When the pipe reaches it, the water rushes up the pipe with great force and flows on to the



Picture 15. Drilling machine in operation

ground. Sometimes the force of the water is so great that the men working the machine cannot stop it. The water may go on flowing for days, weeks, months, and sometimes years. The pipes of some artesian bores go down 5000 feet into the ground, and millions of gallons of water may flow up the pipe each day. In Australia there is an artesian bore which is 5045 feet deep and from which 4,500,000 gallons of water flow daily.

The water from artesian wells and bores can be made to flow into lakes, canals and ditches for use in irrigating the land. Many artesian bores have been made in very dry places, and with the water that comes from them thousands of acres of dry, bare land have been changed to good farm land giving many tons of food each year to people and animals.

There is just one danger: the water from an artesian well or bore may not be good for crops. Some artesian water is hot, and some contains salts that have dissolved in it deep in the ground. The heat of the water or the salts in it may damage the crops.

Irrigation pipes

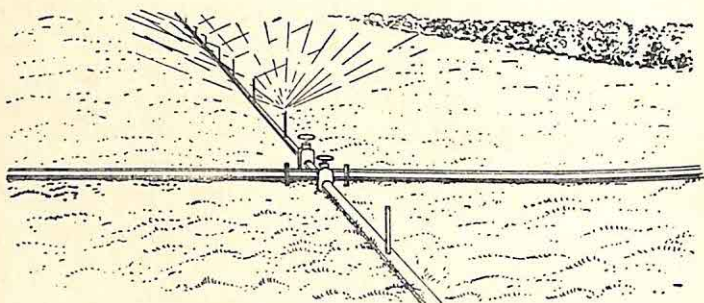
In Book Seven we read about putting pipes under the ground to drain the sub-soil. Pipes are also used to take water to the land where it is needed. Some of these pipes are laid on top of the ground, and take water from rivers and lakes to fields which may be nearby or far away. A field near a river or lake may be irrigated by a number of short pipes each of which goes from the bank of the river to one of the furrows between the rows of plants. Pumps worked by machines raise the water from the river, and make it flow up the pipes when the field is to be irrigated.

In some places the water flows from the pipes into open ditches and from the ditches into the furrows. In other places pipes take the water into the sub-soil. The path

followed by an underground pipe can often be clearly seen, because near it the plants are big and healthy.

Sprays and hoses

Many people use hoses to water their gardens. A hose is a rubber pipe, which can be screwed on to a tap on a metal pipe, and carried or dragged from place to place. If a piece of metal with many small holes in it, called a spray, is screwed to the end of a hose, the water comes out as small drops and falls on the ground like rain.



Picture 16. Spray irrigation

Sprays can also be put on upright pipes, to which the water comes through pipes laid under the ground. The sprays throw the water into the air, and it falls on the garden like gentle, fine rain. Sometimes the spray turns round and round, so that the water is thrown farther and is scattered equally all round. Many people use hoses and sprays every day to water their fruit trees or vegetables in dry weather. The water they use is measured, and they have to pay for it, if it is supplied by the Government.

THINGS TO DO

1. Find out if there are artesian wells or bores near where you live, and go and see them. Find out how deep

they are, how much water they give each day, and what the water is used for.

2. Find out if pipes are used for irrigation in your district. If so, find out how they are used.

3. If there are any hoses or garden sprays in the school or in the shops nearby, find out how they are used and how they work. Ask how they should be kept in good condition, and what should and should not be done with them.

4. Find out if there are any other methods of irrigation in use in your district.

QUESTIONS

1. What is an artesian well? an artesian bore?
2. Why is water from artesian bores sometimes bad for the crops?
3. In what ways can pipes be used for irrigation?

CHAPTER 6

WHAT WE CAN DO

As we have seen, the new ways of irrigating the land cost a great deal of money. But people were irrigating their fields long before man invented machinery to lighten the work of building great dams, digging canals or making deep wells. People took water to their fields centuries ago, when they had only their hands and simple tools with which to do the work. We too can irrigate the land round our villages and schools, if we are prepared to do the work and help each other.

In order to irrigate the land we must do three things. In the first place, we must, of course, bring the water to the land. Secondly, we must control it, that is, be able to

have it when we need it, and be able to stop it when we have had enough. Lastly, when the soil and the plants have had all they can use, we must be able to get the drainage water safely away.

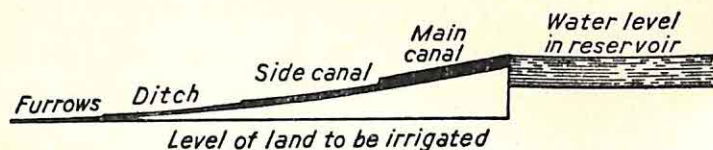
Bringing water to the land

We can bring water to the land only if

- (1) there is a river, lake or spring not far away;
- (2) the land to be irrigated is at a lower level than the place where the water is; and
- (3) ditches can be dug and kept in good order. Ditches cannot be dug in hard rock with only hoes and spades; the sides of ditches dug in sand soon fall in.

Sometimes water can be brought to the land through pipes made by joining long bamboos. When holes have been made in the solid parts of the bamboo, water will flow through it. The bamboo pipe can be placed on forked sticks, which are cut so that the pipe slopes down towards the garden. The river or spring, from which the water comes, must, of course, be higher than the land to be irrigated.

Bamboos are sometimes cut open from end to end and the nodes, which block it, taken out. An open pipe of this kind is easily kept clean, and, though it does not carry much water, it will bring enough to help the land, if the water flows in it all the time. The flow of water to the field can be stopped by taking away a piece of the bamboo at a place where the water can drain away without damag-



Picture 17

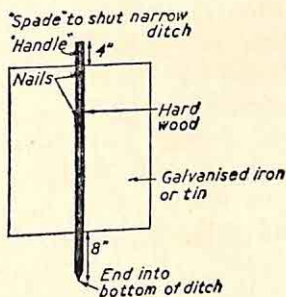
ing either the land or the crops. If one bamboo pipe does not bring enough water, several of them can be placed side by side.

Controlling the flow of water

If the water is brought to the land in a large ditch, it will be made to flow first into smaller ditches and then into furrows. The farmer must be able to stop the water when the plants and the soil have had enough. In Chapter 2 we read how the flow of water in the furrows between or around the plants can be controlled. Chapter 3 tells us how the flow of water in ditches is controlled by wooden or cement doors. We can make a simple kind of door which will do the same work.

A door for narrow ditches

This can be made from a piece of galvanized iron¹ or tin. Cut the tin or iron a few inches wider than the ditch and about six inches longer than the ditch is deep. Then cut a strong piece of wood or straight stick about a foot longer than the sheet of tin or iron. Nail this lengthwise in the middle of the sheet, so that about four inches of the wood sticks out at one end of the sheet and eight inches sticks out at the other end. The four inch end is used as a handle, and the eight inch end is sharpened so that it



Picture 18

¹ Galvanized iron: a sheet of iron covered with a metal which does not rust.

can be pushed down into the soil at the bottom of the ditch (see Picture 18).

When this sheet is pushed down into the ditch, its edges cut into the soil on each side, and the pointed end of the wood sticks into the soil at the bottom. This holds the sheet firmly in the ditch, and the flow of water is stopped. The sheet is easily pulled out when more water is wanted.

Doors for wider ditches

A bag stop can be used to cut off the water in wider ditches. Unpick the sewing of some strong sacks¹ and open them out. Lay them flat on the ground to make a sheet as long as the ditch is wide, and two yards wider than the ditch is deep. Sew the sacking together to keep the sheet this shape. If the sacks are thin, do not unpick the sewing. Sew them together double to make a sheet of the size required.

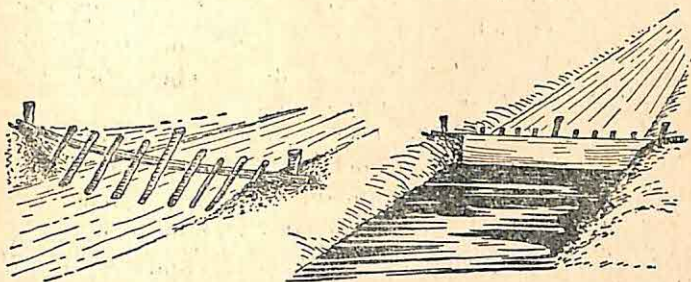
Next cut a straight, strong branch of a tree two feet longer than the width of the ditch. Cut about a dozen more branches so that each is about $1\frac{1}{2}$ feet longer than the ditch is deep.

At the place where the flow of water is to be stopped, push a short, strong piece of stick into the top of the bank on each side of the ditch. Wind the top edge of the sheet two or three times round the long branch. Place this across the ditch so that the sheet hangs from the branch on the side facing upstream. About a foot of the branch should rest on each bank of the ditch, and it should be held in position by being placed against the upstream side of the short pieces of stick, which have already been pushed into the bank. These pieces of stick will keep the sheet from being washed away by the water.

¹ Sack : a large bag made of coarse cloth.

Now take the dozen or so short branches and place them under the sheet, so that one end of each is on the bottom of the ditch on the upstream side of the sheet, and the other end is resting on the branch to which the sheet is attached (see Picture 19). The sheet will now slope towards the flow of the water, and 3 to 5 feet of it will be lying on the bottom of the ditch. Spread out this part of the sheet and put stones on it to hold it firmly in place.

The bag stop is now ready. Water will drip through the sheet, but it will not flow through it. The sheet will hold the water back while we are irrigating on the upstream



Picture 19. Bag stop

side of the bag stop. When we have finished with the bag stop in one place, we can move it for use in another place, or we can hang it up to dry.

If we want some water, but not the full flow, in the ditch beyond the bag stop, we can push the sheet along the branch away from the side of the ditch. Water will flow through the opening we have made, but there is a danger that it will flow quickly enough to wash away the soil from the side of the ditch. It is better to make a "door" in the sheet, as described below.

It may be useful to have several bag stops, so that when one is stopping the water in one place, we can be put-

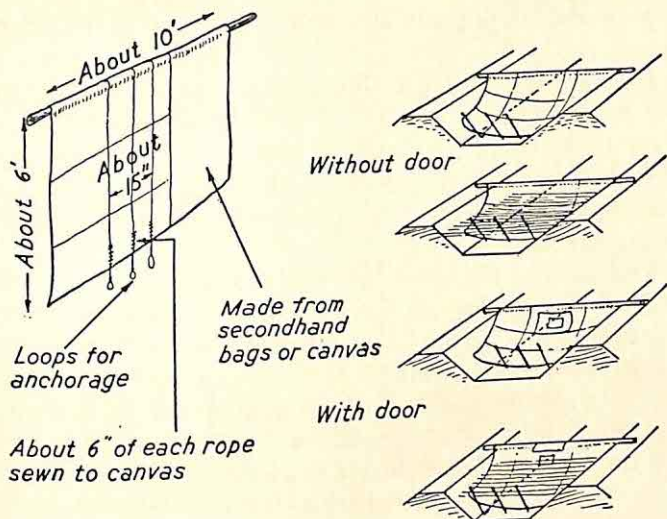
ting another in position where we want to stop the water next.

Here are some ways in which the bag stop just described can be improved. Instead of winding the sheet two or three times round the straight branch, turn the top side of it over and sew it to make a hem wide enough for the branch to go through. This attaches the sheet more firmly to the branch.

The place of the short branches holding the sheet at an angle to the bottom of the ditch can be taken by strong ropes, which are longer than the sheet and are sewn from top to bottom of it. At the lower end of each rope there is a loop, through which a strong stick can be threaded and driven into the bottom of the ditch. These sticks hold out the sheet and fix it firmly in place.

In the top part of the sheet a door can be made to let some of the water flow through. In the middle of the sheet and about eight inches from the top, cut a square hole, each side of the square being about eight inches long. From another piece of sacking cut a square with each side two feet long to make the "door". Sew one side of this to the sheet above the hole, so that it falls over and covers the hole on the upstream side of the sheet. When the door is shut, the water will press it against the sheet and none will get through. When some water is wanted, the door can be pulled up to let through the amount required.

If the sheets are cared for, they will last a long time. When not in use, they should be hung up to dry, and then folded and put away until they are needed again. If they are left in the ditch or lying about on the ground, they will quickly rot away.



Picture 20. Improved bag stop

Drainage of the irrigation water

When water has been brought to the garden and made to flow through the ditches and furrows to irrigate the soil and the plants, the farmer's work is not finished. Some of the water will soak into the soil, but, until the farmer has learnt how much the soil needs, much will flow away over the land. Even when he knows how much to give, there will always be some water that has to be taken away by the drainage furrows and ditches or through the soil itself. There must be good drainage for this water, and it must be taken away to a safe place where it will damage neither the farmer's own land and crops nor those of other people.

Ditches must be dug in the right places to lead the drainage water to a river, lake or other place where it can do no harm. Wide, shallow, grass-covered waterways are even

better than ditches, for the water flows away slowly through the grass, and does not damage the land.

Irrigation makes much work, but the better crops more than repay the farmer for the extra work he does. Good crops mean more food, healthy people, and a richer country. Irrigation in a school or a village or a district brings people together to share in the work and help each other. They get to know each other better, and learn to think of others besides themselves. This kind of fellowship is worth even more than the good health and riches which irrigation can bring to the people.

THINGS TO DO

1. Make a bag stop. If there is a class, half can make the simpler kind of bag stop, and the other half the improved one.
2. If bamboos grow in the district, make both kinds of bamboo pipe described in this chapter. Take water to the garden in them. Which kind do you like better?

QUESTIONS

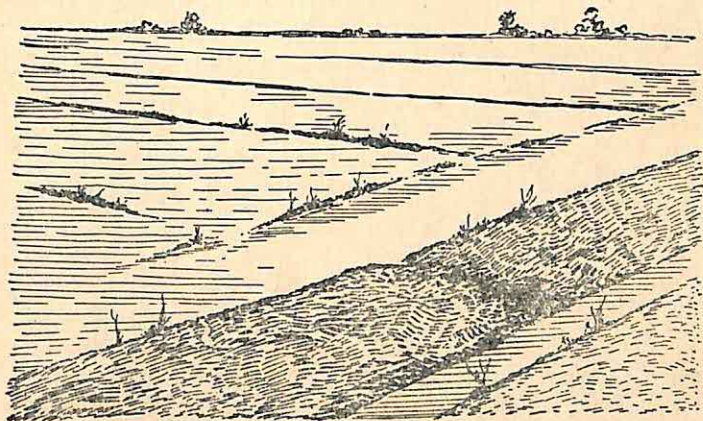
1. What three things must we be able to do in order to irrigate the land?
2. Draw a picture of a bag stop with a "door" in it.
3. When a bag stop is put into a ditch, should the sheet be spread out and fastened down on the upstream or the downstream side of the branch from which it hangs?
4. Why is a grass-covered waterway better than a ditch for taking away drainage water?

CHAPTER 7

HOW IRRIGATION MAY DO DAMAGE

IN order to get the best results from irrigation we must take care to avoid its dangers. Too much water can damage the soil just as much as too little, and irrigation becomes harmful if it makes the water table too high. This can happen if the land receives too much water, or if the water cannot drain away.

The land may receive too much water if heavy rain comes just after the fields have been irrigated. If no more water can soak into the soil, ditches and canals may overflow, causing damage to the fields and crops. Some of the crops may even be destroyed. Perhaps the farmer



Picture 21. Over-watering

cannot foresee the rain coming at the wrong time, but he can foresee that it may happen. It might be wiser for him to give his fields less water when irrigating them, and to irrigate them again if the rain does not come. This would mean more time and work, but it might save damaging the land and crops, and lead to a better harvest at the end of the season.

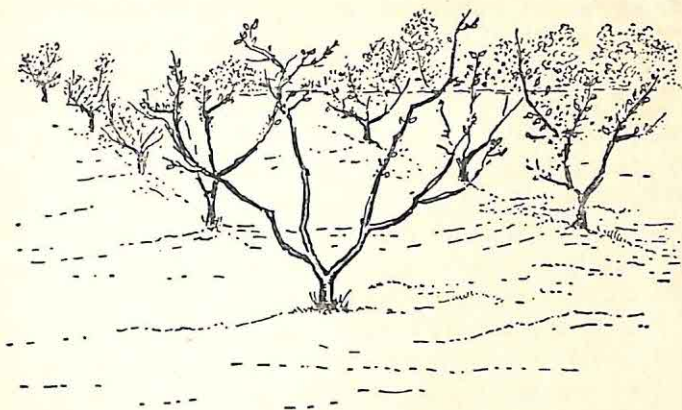
If the water cannot drain away well, the farmer must see that it does. He must watch for signs of bad drainage, and try to improve it where necessary.

Irrigation water may leach¹ the plant foods from the soil. It may do so because it is flowing too quickly through the soil, and is carrying the plant foods away with it. The farmer should watch the crops and the harvests. If they are getting poorer, the reason may be the leaching of plant food from the soil.

In the soil there are other things besides plant foods which dissolve in water. Some of these things are poisons, and, if they reach the plants, may kill them. If irrigation water not needed by the plants cannot drain away, it evaporates. Water in the capillary paths rises to take its place, and may bring with it poisons which have dissolved in it deeper down in the soil. When the capillary water in its turn evaporates, these poisons remain in the top-soil. When enough of them have collected there, they kill the plants. Soon nothing will grow there—the land has become sterile. This condition of the land is known as “salt sterility”, because the poisons are “salts”, of which the salt we use in food is one. The farmer must make sure, by draining his land properly, that the water table does not rise high enough to allow salts to get into his top-soil.

Crops in irrigated fields are often “dirty”, that is they have dust and insects on them. Irrigation brings water only to the roots of the plants. Rainwater washes the

¹ Leach : wash away.



Picture 22. Salt sterility killing fruit trees

leaves and stems of the plants, carries away the dust from them, and drowns the insects.

To get the best possible results from irrigation, we must

1. have good drainage;
2. control the irrigation water so that it
 - (a) flows slowly and soaks into the soil,
 - (b) soaks down to the ends of most of the roots, and
 - (c) does not make the soil too wet;
3. Remember that:
 - (a) different kinds of soil need different amounts of water,
 - (b) different crops need different amounts of water,
 - (c) the same crop may need different amounts of water at different times, for example, rice when young and at harvest time, and
 - (d) the amount of water the crops and soil need from irrigation depends on the amount they get from the rain.

CHAPTER 8

WHAT IRRIGATION IS DOING IN THE WORLD

IRRIGATION not only takes to the crops the water they need, but also helps them to get the food they require. Plants can use only the food that has dissolved in water, and irrigation unlocks the door to the store of plant food in the soil. In the soft, damp soil the roots of plants grow well and quickly, and take in the food the plants need. Stems, leaves, and flowers grow well on the healthy plants, and the harvests are big.

When the crop is finished, there are many stems and leaves that will rot in the soil to make humus. Humus protects the soil and helps to feed the next crop.

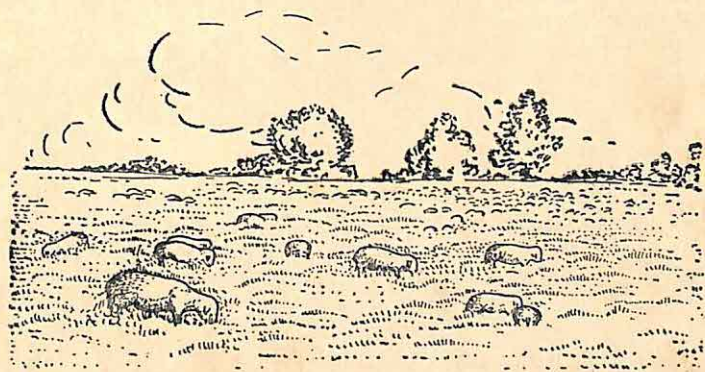


Picture 23. Land made ready for irrigation

Strong plants with good roots and big leaves help to protect the soil from erosion. The roots hold the soil and prevent it from being washed away by heavy rain. The leaves protect the soil from sun and wind.

Irrigation allows the farmer to plant at the right time, without waiting for the rain. It saves the crops if the rain does not come. It allows the farmer to plant crops, which would not otherwise grow in that district. It allows new crops to be introduced.

Irrigation helps the dairy¹ farmer also, because he can have good grass if he has plenty of water. When the grass is good, the sheep and cattle are strong. The farmer gets plenty of good milk and meat to sell. Irrigating pasture² land allows the farmer to plant grasses that may be better than the kind that grew there before. More and better grass helps the farmer to improve his sheep and cattle. Better sheep and cattle mean more food for the people, and more profit for the farmer.



Picture 24. Sheep on irrigated pastures

¹ Dairy: a place where cows are kept for producing milk.

² Pasture: grass-land for cattle.

THINGS TO DO

1. Plant two roots of grass each in a separate pot. Both pots should contain the same kind of soil. Give pot A plenty of water, but give pot B only enough water to keep the grass alive. After two weeks take up the plants carefully. Wash the soil gently from the roots. Which plant has the bigger and stronger roots? Why is this?

2. During the next month watch the garden for insect pests and diseases. Note which plants are attacked first. Are they the weakest or the strongest?

3. Is there a crop that might grow well in your district, if it could be given plenty of water? Try growing it in an irrigated part of your garden.

4. Try to discover if irrigation has improved the harvests or the grass in your district. The Agricultural Officer will be able to tell you.

QUESTIONS

1. What kind of farm is a dairy farm? How can irrigation help dairy farming?

2. How can irrigation help the farmer in his fight against (a) erosion, (b) plant diseases.

Farming Series

1. The First Farmers
2. The Farmer's Soil
3. The Farmer's Friends in the Soil
4. Better Ways of Farming
5. Feeding the Soil
6. More Food for the Soil
7. Draining the Soil
8. Irrigating the Soil
9. Soil Erosion
10. Soil Conservation

